EXHIBIT 1

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

CYWEE GROUP LTD., ***Plaintiff,*** **SAMSUNG ELECTRONICS CO., LTD. AND SAMSUNG ELECTRONICS AMERICA, INC.** ***Defendants.***	**CASE NO. 2:17-cv-00140-RWS-RSP** **JURY TRIAL DEMANDED**

DECLARATION OF JOSEPH J. LAVIOLA, JR., PH.D.

I hereby declare as follows:

1. I have been asked by counsel for Plaintiff CyWee Group Ltd. ("CyWee") to offer my opinions regarding claim construction and indefiniteness for certain terms.

2. In connection with the preparation of this Declaration, I have reviewed the materials listed below:

- U.S. Patent No. 8,441,438 (the "'438 patent"),
- U.S. Patent No. 8,552,978 (the "'978 patent"),
- The file wrappers for both the '438 and '978 patents,
- The parties' respective Patent L.R. 4-2 preliminary claim constructions and materials,
- The parties' revised claim constructions, and
- Any additional evidence cited herein.

3. All of the opinions stated in this Declaration are based on my personal knowledge and professional judgment. If called as a witness, I am prepared to testify competently about them.

I. EXPERIENCE AND QUALIFICATIONS

4. I have almost 20 years of experience working in the virtual reality ("VR") and augmented reality ("AR") fields, as well as advancing three-dimensional ("3D") interaction techniques for use in both VR and AR environments. More specifically, I have worked extensively on and with user and object motion tracking sensors, algorithms and systems.

5. I have been elected the Charles N. Millican Faculty Fellow and Associate Professor in the Department of Computer Science at the University of Central Florida, located in Orlando, Florida. I also serve as the Director of both the Interactive Computing Experiences Research Cluster of Excellence and the Modeling and Simulation Graduate Program at the University of Central Florida. Through these functions, I supervise over fifteen graduate and undergraduate students working on various research projects in the area of human-computer interaction. In addition, since 2013, I have served as an Adjunct Associate Professor of Computer Science at Brown University, located in Providence, Rhode Island.

6. I received my Bachelor of Science degree in Computer Science from Florida Atlantic University in 1996. I also hold two Master's degrees – an Sc.M. in Computer Science and an Sc.M. in Applied Mathematics from Brown University – which were awarded in 2000 and 2001 respectively. I received my Ph.D. in Computer Science from Brown University in 2005.

7. I serve as Associate Editor for various publications in the area of human-computer interaction, including the International Journal of Human-Computer Studies, the Association for Computing Machinery's Transactions on Interactive Intelligent Systems, and the Institute of Electrical and Electronics Engineers' ("IEEE") Computer Graphics & Applications. I have also served as Program Chair for the IEEE Virtual Reality conference.

8. I have contributed to more than 40 peer-reviewed journal publications and nearly

100 refereed conferences and workshops, the majority of which deal with virtual and augmented reality and user and object motion tracking. For instance, I am the lead author of the second edition of the most comprehensive textbook on 3D user interaction, entitled "3D User Interfaces: Theory and Practice." As part of that work, I analyzed many different types of input and output hardware, 3D user interfaces and general topics related to virtual and augmented reality. I have also worked specifically with sensors and algorithms related to the '438 and '978 patents.

9. A more complete list of my qualifications is set forth in my curriculum vitae, a copy of which is attached hereto as Exhibit A.

10. I am being paid for work in this matter. My compensation is in no way dependent upon the outcome of this litigation nor do I have a personal interest in the outcome of this litigation.

II. LEVEL OF ORDINARY SKILL IN THE ART

11. A person of ordinary skill in the art at the time of the filing of the '438 and '978 patents would typically have at least a Bachelor's Degree in Computer Science, Electrical Engineering, Mechanical Engineering, or Physics, or equivalent work experience, along with knowledge of sensors (such as accelerometers, gyroscopes, and magnetometers), and mobile computing technologies.

III. CLAIM CONSTRUCTION AND INDEFINITENESS STANDARDS

12. I have been instructed that the following standards apply to claim construction and indefiniteness.

13. The words of a claim are to be given the plain and customary meaning that a person of ordinary skill in the art would have understood the claim language to have, as of the effective filing date of the patent application, in light of the claims, specification, and prosecution history. A court should derive the meaning of a claim term by looking to the claim language, the

specification, and the prosecution history. Claim construction always begins with the language of the claims themselves. A court may also consider evidence extrinsic to the patent, although such evidence is generally less significant than the intrinsic record when determining the meaning of the claim language. A person of ordinary skill may act as his or her own lexicographer and define a term to have a particular meaning.

14. There is a heavy presumption that a claim term carries its plain and ordinary meaning, and that a court need not construe a term, particularly when the plain and ordinary meaning of the term is sufficient. Instead, claim construction is necessary only when the meaning or scope of technical terms is unclear.

15. A claim term is invalid for indefiniteness if, when read in light of the patent's specification and prosecution history, it fails to inform, with reasonable certainty, those skilled in the art about the scope of the invention. Definiteness is measured from the viewpoint of a person skilled in the art at the time the patent was filed. Reasonable certainty, not absolute certainty, is required because the definiteness requirement must take into account the inherent limitations of language, and thus some modicum of uncertainty is the price of ensuring the appropriate incentives for innovation. Close questions of indefiniteness must be resolved in favor of the patentee.

16. If a claim term is indefinite, the claim is invalid. The party challenging validity bears the burden of proof on this issue, and must prove, by clear and convincing evidence, that the term is indefinite. Clear and convincing evidence requires that the challenging party prove that it is highly probably that the challenger's contention is correct. In evaluating a term for indefiniteness, I have been told that the meaning of the words depends on the context of the term used within the claim and specification.

IV. OPINIONS REGARDING SPECIFIC TERMS

A. "utilizing a comparison to compare the first signal set with the second signal set" ('438 patent claim 1)

17. CyWee proposes that this term be construed as "determining or assessing differences based on a previous state associated with the first signal set and a measured state associated with the second signal set while calculating deviation angles." Samsung alleges that this term is indefinite. In my opinion this term is not indefinite because it informs, with reasonable certainty, a person of ordinary skill in the art, of the scope of the invention. Further, it is my opinion that this term has the meaning proposed by CyWee when read by a person of ordinary skill in the art in light of the intrinsic evidence.

18. "Comparison" of two values in mathematics and computer science generally refers to determining or assessing differences between those values as required by CyWee's construction. That determination may be a relation between them, e.g. they are equal or unequal and one is larger than the other. Comparison can also refer to assessing by what amount two values are different. One approach to this assessment would be to subtract one value from another to determine the difference. If two values cannot be directly compared, such as being in different units or different physical quantities, values can often be mapped or transformed to a common state/units/space before comparison. For example, when comparing monetary amounts in different currencies (i.e. rubles vs. francs), those currencies can be converted to a common currency.

19. The '438 patent itself provides support for CyWee's construction. The "comparing" as used in claim 1 corresponds to the process of using the calculation of actual deviation angles to compare the current state (i.e., the second quaternion) with the measured state (i.e., the measured axial accelerations and predicted axial accelerations) during the calculation of deviation angles.'438 patent 2:26-32 ("The term of 'comparison' of the present invention may generally

refer to the calculating and obtaining of the actual deviation angles of the 3D pointing device 110 with respect to the first reference frame or spatial pointing frame Xp, Yp, Zp utilizing signals generated by motion sensors while reducing or eliminating noises associated with said motion sensors."). Thus, the term "comparison" is referring to the "enhanced comparison method" described in the patent.

20. Claim 1 states that the previous state is associated with the first signal set and the measured state is associated with the second signal set as required by CyWee's construction. And the patent states that the comparison method is used to calculate and output resulting deviations by comparing these signal sets. For example:

(1) ". . . the present invention provides an enhanced ***comparison method*** to correctly calculating and outputting a resulting deviation comprising a set of resultant angles including yaw, pitch and roll angles in a spatial pointer frame, preferably about each of three orthogonal coordinate axes of the spatial pointer reference frame, ***by comparing signals of rotation sensor related to angular velocities or rates with the ones of accelerometer related to axial accelerations*** such that these angles may be accurately outputted and obtained." '438 patent 4:32-40 (emphases added).

(2) "In other words, in one embodiment as shown in step 735, it is preferable to ***compare*** the second quaternion in relation to the ***measured angular velocities of the current state*** at present time T ***with the measured axial accelerations*** Ax, Ay, AZ ***as well as the predicted axial accelerations*** Ax', Ay', AZ' also at present time T." '438 patent 13:28-39 (emphases added).

21. This process is further illustrated in Figures 7 and 8. In these figures and citations, the patent states that the comparison method compares the first signal set (i.e. rotations or angular velocities such as from a gyroscope) to the second signal set (i.e., accelerometer). Because the angular velocities and axial accelerations are different quantities, a person of ordinary skill in the art understands that a direct comparison of the angular velocities and axial accelerations is not performed. Rather, the comparison is done by conversion to a ***common state,*** namely, the ***previous***

state (first quaternion) is updated using the angular velocities (first signal set) to generate a second quaternion. The second quaternion is used to generate predicted accelerations (***predicted state***), which are compared to the measured accelerations (***measured state*** or second signal set). *Id.* 3:53 (enhanced calculating or comparison method capable of accurately obtaining and calculating actual deviation angles in the spatial pointer frame), 3:63 (enhanced comparison method applicable to the processing of signals of motion sensors such that errors and/or noises associated with such signals or fusion of signals from the motions sensors may be corrected or eliminated); *see also id* 4:21-65, 5:55-67, 6:1-26, 8:33-58, 10:53-11:47, 13:25-43, 13:44-14:23, 15:8-19, 15:37-40, 19:4-26, 20:28-37, 21:33-38, 22:42-47.

22. Given that the term "comparison" in this context refers to the "enhanced comparison method" described in the '438 patent and that anyone of ordinary skill in the art would understand that this generally refers to an Extended Kalman filter, the enhanced comparison method updates the current state and creates an updated quaternion using Equations 5-11 described in the '438 patent. Note that equations 5-11 ensure that a direct comparison between the angular velocities and axial accelerations can be compared by creating a common state that ensures the comparison is done properly. Figures 7 and 8 outline the entire process. For these reasons, this term is not indefinite and has the meaning proposed by CyWee.

B. "comparing the second quaternion in relation to the measured angular velocities ωx, ωy, ωz of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax′, Ay′, Az′ also at current time T" ('438 patent claims 14, 19)

23. CyWee proposes that this term need not be construed. In the alternative, CyWee proposes that this term be construed as "utilizing the second quaternion obtained from the measured angular velocities ω_x, ω_y, ω_z of the current state at current time T, the measured axial accelerations Ax, Ay, Az, and the predicted axial accelerations Ax′, Ay′, Az′ also at current time

T to obtain an updated state or updated quaternion." Samsung alleges that this term is indefinite. In my opinion this term is not indefinite because it informs, with reasonable certainty, a person of ordinary skill in the art, of the scope of the invention. Further, it is my opinion that, while this term need not be construed, it has the meaning proposed by CyWee.

24. The '438 patent provides support for CyWee's construction. Figures 7 and 8 are flowcharts that describe a sensor fusion algorithm such as that used in claims 14 and 19. One of the goals of the patented invention is to utilize an "enhanced comparison method for eliminating accumulated errors of said six-axis motion sensor module to obtain deviation angles corresponding to movements and rotations of said 3D pointing device in a spatial pointer reference frame." '438 patent 4:55-59. Figures 7 and 8 describe the use of 3 quaternions as part of the enhanced comparison method, which a person of ordinary skill in the art would recognize as a filtering algorithm that has properties similar to a Kalman filter, and which may be described as an Extended Kalman filter. This comparison method repeats itself after it computes an updated quaternion (3rd quaternion) as part of a loop as shown in Figures 7 and 8.

25. Figures 7 and 8 show that the first quaternion, although not part of CyWee's construction of this term, is a quaternion representing orientation at a previous time T-1, which can either come from an initialization step ('438 patent 11:62-64) or the result of the updated or third quaternion computed at time T ('438 patent 14:39-40). Figures 7 and 8 illustrate the loop by which the third quaternion may be set to the first quaternion in a subsequent iteration of the loop.

26. The second quaternion is computed using the angular velocities ω_x, ω_y, ω_z measured from the rotation sensor or gyroscopes at current time T (*see* '438 patent 7:64-65, '438 patent 9:16-17, and '438 patent 12:32-34) and the first quaternion defined above. The '438 patent further illustrates this step through the use of Equation 1, which is used to compute the second quaternion

as shown as step 720 in Figures 7 and 8. *See also* ’438 patent 12:40-60 (describing Equation 1).

27. The ’438 patent clearly states that measured axial accelerations Ax, Ay, Az originate from the accelerometer or accelerometers at current time T. Claim 1 explicitly requires “an accelerometer for detecting and generating a second signal set comprising axial accelerations Ax, Ay, Az.” And step 725 in Figures 7 and 8 state that the “measured axial accelerations” are obtained at time T. This understanding is consistent with several other disclosures in the patent. *E.g.*, ’438 patent Abstract, 8:4-8, 9:18-19, 12:64-66.

28. Further, the patent clearly describes, in step 730 that the predicted axial accelerations are calculated at current time T. Figure 7 also shows that the predicted axial acceleration will then be combined with the second quaternion and the measured axial acceleration utilizing an enhanced comparison method.

29. The ’438 patent also describes how the second quaternion, measured axial accelerations, and predicted axial accelerations are combined together as part of this “enhanced comparison method” to compute the updated state or third quaternion as shown in step 735 in Figures 7 and 8. The enhanced comparison method updates the current state and creates an updated quaternion using Equations 5-11 described in the ’438 patent. A person of ordinary skill in the art, will recognize these equations as elements of an extended Kalman Filter, which is used for estimating orientation.

30. Finally, CyWee’s construction is consistent with the patent’s teaching that the term “comparison” in the “present invention may generally refer to the calculating and obtaining of the actual deviation angles of the 3D pointing device 110 with respect to the first reference frame or spatial pointing frame Xp, Yp, Zp utilizing signals generated by motion sensors while reducing or eliminating noises associated with said motion sensors.” ’438 patent 2:26-32. Figures 7 and 8

describe generally how these deviation angles are calculated using motion sensor information to reduce noise.

31. Given these explanations, it is my opinion that this term is not indefinite because it informs, with reasonable certainty, a person of ordinary skill in the art as to the scope of the claim. It is also my opinion that, while this term need not be construed, it has the meaning proposed by CyWee.

C. "three-dimensional (3D) pointing device"/"3D pointing device" ('438 patent claims 1, 3, 4, 5, 14, 15, 16, 17, 19)

32. CyWee proposes that this term need not be construed. In the alternative, CyWee proposes that this term may be construed as "a handheld device that uses at least a rotation sensor comprising one or more gyroscopes, and one or more accelerometers to determine deviation angles or the orientation of a device." Samsung alleges that this term should be construed as "a device that detects the motion of the device in three-dimensions and translates the detected motions to control the movement of a cursor or pointer on a display." In my opinion this term has the meaning proposed by CyWee when read in light of the intrinsic evidence.

33. The '438 patent itself provides support for CyWee's construction. Claim 1 explicitly requires "a ***rotation sensor*** for detecting and generating a first signal set comprising ***angular velocities*** ω_x, ω_y, ω_z." (emphasis added). The specification states that the rotation sensor can include more than one gyroscope: "the abovementioned ***rotation sensor may comprise three gyroscopes*** corresponding to each of the said angular velocities of ω_x, ω_y, ω_z in a 3D spatial pointer reference frame of the 3D pointing device." '438 patent 5:24-26 (emphasis added). Claim 1 also explicitly requires "a rotation sensor for detecting and generating a first signal set comprising ***angular velocities*** ω_x, ω_y, ω_z." (emphasis added). The specification states that the accelerometer may in fact include multiple accelerometers: "the abovementioned ***accelerometer may comprise***

three accelerometers corresponding to each of the said axial accelerations Ax, Ay, Az in a 3D spatial pointer reference frame of the 3D pointing device." '438 patent 5:28-31 (emphasis added).

34. Unlike independent claim 1, independent claims 14 and 19 do not include the terms "accelerometer" or "rotation sensor." But a person of ordinary skill in the art would understand those claims to require one or more accelerometers due to those claims' requirement of "obtaining measured axial accelerations Ax, Ay, Az gained from the motion sensor signals of the six-axis motion sensor module at the current time T." And a person of ordinary skill in the art would understand those claims to require a rotation sensor comprising one or more gyroscopes due to those claims requirement of ""obtaining measured angular velocities ω_x, ω_y, ω_z gained from the motion sensor signals of the six-axis motion sensor module at a current time T."

35. Further, the specification repeatedly discloses a portable ***handheld*** device. More specifically, Figures 1 and 2 disclose prior art pointing devices, and Figures 3 and 5 disclose embodiments of the present invention. All are handheld devices. For example, the specification states "FIG. 1 is a schematic diagram showing a user using a handheld 3D pointing device . . . ." 1:28-30.

36. The specification also repeatedly discloses that the pointing device is for determining deviation angles or the orientation of the device as required by CyWee's construction. For example, the Abstract describes "A three-dimensional (3D) pointing device capable of accurately outputting a deviation . . . ." Figures 7 and 8 provide flow charts of the patented invention. The last step in Figure 7 and the second-to-last step in Figure 8 is "[o]btain resultant deviation . . . ." And embodiments of the invention similarly describe deviation angles. *E.g. Id.* 4:6-19 ("According the one aspect of an example embodiment of the present invention . . . such that resulting deviation including resultant angles . . . of the 3D pointing device subject to

movements and rotations in dynamic environments may be obtained . . . .); 4:65-5:3 ("In other words, the present invention is capable of accurately outputting the abovementioned deviation angles . . . to eliminate or reduce accumulated errors and noises . . . .").

37. In my opinion, Samsung's proposed construction improperly adds the requirement that "detected motions . . . control the movement of a cursor or pointer on a display." First, the asserted claims (1, 3, 4, 5, 14, 15, 16, 17, and 19) do not require that a pointer or anything else is displayed. In contrast, claims 8, which depends from claim 1, may be read to require visual output, as it requires "translating said resultant angles . . . to a movement pattern in a display reference frame . . . ." Inclusion of this limitation in claim 8 suggests that it required by other claims (other than claim 9 which depends from claim 8 and has not been asserted in this case). Second, the '438 patent discloses embodiments in which information need not be displayed. For example, Figure 7 discloses an embodiment "for obtaining a resulting deviation including resultant angles" but does not disclose that information is displayed. In contrast, the embodiment disclosed in Figure 8 requires a 3D pointing device that "translate[s] the resultant angles to ***movement pattern*** in the display reference frame." (emphasis added). And there is no requirement that the "movement pattern" displays a "cursor or pointer" as required by Samsung's construction. Third, the patent discloses an embodiment in which the display is integrated with the pointing device itself. *Id.* Fig. 6. The specification states that, in such an embodiment the computing processor ***may*** map the resulting deviation to a ***movement pattern*** appearing on the integrated display:

> The computing processor 648 of the processing and transmitting module 604 ***may too perform the mapping of resultant deviation*** from or in said spatial reference frame or 3D reference frame to a display reference frame such as a 2D reference frame by translating the resultant angles of the resulting deviation of the electronic device 600 in the spatial reference frame, preferably about each of three orthogonal coordinate axes of the spatial reference frame ***to a movement pattern in a display reference frame*** associated with the electronic device 600 itself. ***The display 682 displays the aforementioned movement pattern***.

Id. 10:29-39. There is no requirement that the movement pattern includes a pointer or cursor. Similarly, the embodiment disclosed in Figure 8 discloses a 3D pointing device that "translate[s] the resultant angles to ***movement pattern*** in the display reference frame." (emphasis added). In yet another embodiment, the specification discloses that a cursor may but need not be displayed, and that other "video effects" may be displayed instead. *Id.* 17:36-40 ("The display device ***may*** display a cursor ***or some video effect*** on the display screen 910 to highlight the position of the target point 924.").

38. In my opinion, Samsung's construction is overly narrow in light of these disclosures. Thus, it is my opinion that while this term need not be construed, it has the meaning proposed by CyWee.

D. "six-axis motion sensor" ('438 patent claims 1, 5, 14, 15, 16, 17, 19)

39. CyWee proposes that this term need not be construed. In the alternative, CyWee proposes that this term be construed as "a rotation sensor comprising one or more gyroscopes for collectively generating three angular velocities and one or more accelerometers for collectively generating three axial accelerations where said gyroscope(s) and accelerometer(s) are mounted on a common PCB." Samsung proposes that this term be construed as "a module consisting of two types of sensors: (i) a rotation sensor and (ii) one or more accelerometers." In my opinion, this term has the meaning proposed by CyWee.

40. I have been informed that construction begins with the language of the claims themselves. Here, claim 1 requires "a six-axis motion sensor module . . . ***comprising*** a rotation sensor . . . an accelerometer . . ." (emphasis added). Here, the patentee's choice of the term "comprising" indicates that the six-axis motion sensor may include additional components, such as a processor and additional sensors. Similarly, the Abstract describes a "six-axis motion sensor

module ***including*** a rotation sensor and an accelerometer." (emphasis added). Once again, the patentee's use of the term "including" indicates that the motion sensor may include other components.

41. This understanding is further supported by the specification, which routinely uses open-ended phrases such as "comprises" or includes" when describing a six-axis motion sensor. *E.g., id.* 5:18-23 ("In one preferred embodiment of the present invention, the six-axis motion sensor module ***comprises*** a rotation sensor capable of detecting and generating angular velocities of ωx, ωy, ωz and an accelerometer capable of detecting and generating axial accelerations of Ax, Ay, Az."); 10:24-25 ("the six-axis motion sensor module 602 may ***comprise*** the rotation sensor 642 and the accelerometer 644."). The '438 patent also discloses an embodiment with a "combination of motion sensors" and uses the term "including" in stating that the combination of motion sensors includes at least accelerometers and gyroscopes capable of providing 6-axis output. It allows for more.

> According to another aspect of the present invention, the present invention provides an enhanced comparison method to eliminate the accumulated errors as well as noises over time associated with signals generated by a ***combination of motion sensors, including*** the ones generated by ***accelerometers Ax, Ay, Az*** and the ones generated by ***gyroscopes ωx, ωy, ωz*** in dynamic environments. In other words, accumulated errors associated with a fusion of signals from a motions sensor module comprising a plurality of motion sensors to detect movements on and rotations about different axes of a reference frame may be eliminated or corrected. *Id.* 4:20-30.

42. Samsung's construction requires that the six-axis motion sensor ***consist of*** nothing more than two types of sensors: a rotation sensor and one or more accelerometers, and excludes a motion sensor that includes additional components. This is inconsistent with the express language of claim 1 and the citations above.

43. Further, unlike CyWee's construction, Samsung's inclusion of the term "module" could be read to require that the accelerometer and rotation sensor cannot be separate or separated.

This is inconsistent with the specification as well. A sample embodiment of the six-axis motion sensor is shown in Figure 6. *See also* ’438 patent 7:1-4 (“FIG. 6 is an exploded diagram showing a 3D pointing device utilizing a six-axis motion sensor module . . . .”). Consistent with CyWee’s construction, Figure 6 shows a ***separate*** accelerometer (644) and rotation sensor (642) mounted on a common PCB 640). *See also id.* 10:18-28 (describing components). Similarly, Figure 5 shows a six-axis motion sensor module (502) with a ***separate*** accelerometer (544) and rotation sensor (542) mounted on a common PCB. *See also id.* 9:11-19 (describing components).

44. Finally, CyWee’s construction is consistent with the specification and explicitly allows for the inclusion of more than one accelerometer and for the rotation sensor to ***include one or more gyroscopes***. This adds clarity to CyWee’s construction and is consistent with the following embodiment from the specification, which uses the term “comprise:”

> It can be understood that in another preferred embodiment, the abovementioned ***rotation sensor may comprise three gyroscopes*** corresponding to each of the said angular velocities of ω_x, ω_y, ω_z in a 3D spatial pointer reference frame of the 3D pointing device; whereas the abovementioned ***accelerometer may comprise three accelerometers*** corresponding to each of the said axial accelerations Ax, Ay, Az in a 3D spatial pointer reference frame of the 3D pointing device.” ’438 patent 5:23-26.

In contrast, Samsung’s construction fails to provide any guidance regarding the meaning of the term “rotation sensor.”

45. For these reasons, it is my opinion that, while this term need not be construed, it has the meaning proposed by CyWee.

E. “using the orientation output and the rotation output to generate a transformed output associated with a fixed reference frame associated with a display device” (’978 patent claim 10)

46. CyWee proposes that this term be construed as “using the orientation output and the rotation output to generate a transformed output ***represented by 2-dimensional movement*** in a fixed reference frame that is parallel to the screen of a display device.” Samsung proposes that this

term be construed as "using the orientation output and the rotation output to generate a transformed output ***representing a 2-dimensional movement*** in a fixed reference frame that is parallel to the screen of a display device." In my opinion, this term has the meaning proposed by CyWee.

47. Both proposed constructions are similar. The intrinsic evidence confirms that transformed output represents movement as required by both constructions. For example, one embodiment states:

> The transformed output <d_x, d_y> represents a ***2-dimensional movement*** in a display plane in the fixed reference frame parallel to the screen of the display device, such as the display plane X_DY_D of the display device **120** shown in FIG. 1 and FIG. 2, wherein d_x represents the movement along the X_D axis and d_y represents the movement along the Y_D axis. In addition, the transformed output <dx, d_y> may represent a ***segment of movement*** in the display plane.

'978 patent 31:59-67. And Figure 8 discloses an embodiment of a 3D pointing device that "translate[s] the resultant angles to ***movement pattern*** in the display reference frame." (emphasis added). The specification states that, in the embodiment shown in Figure 6, in which the pointing device and display are integrated as a single unit, the computing processor may map the resulting deviation to a ***movement pattern***:

> The computing processor 648 of the processing and transmitting module 604 ***may too perform the mapping of resultant deviation*** from or in said spatial reference frame or 3D reference frame to a display reference frame such as a 2D reference frame by translating the resultant angles of the resulting deviation of the electronic device 600 in the spatial reference frame, preferably about each of three orthogonal coordinate axes of the spatial reference frame ***to a movement pattern in a display reference frame*** associated with the electronic device 600 itself. ***The display 682 displays the aforementioned movement pattern***.

Id. 13:48-59.

48. The two constructions differ in that CyWee's construction requires that the transformed output is ***represented by*** a two-dimensional movement, while Samsung's construction requires that transformed output ***represents*** two-dimensional movement. In other words,

Samsung's construction explicitly connotes that the transformed output cannot represent three-dimensional movement (i.e., it cannot represent translations and/or rotations in more than two directions). In my opinion, this is contrary to the teachings of the '978 patent. The'978 patent teaches tracking of movement in three dimensions. For example, claim 10 requires a 9-axis motion sensor. Further, claim 10 teaches the use of an accelerometer, gyroscope, and magnetometer, each having the capability of providing 3-axis output (rather than 2-axis output). Thus, the sensors track 3-dimensional movement rather than two-dimensional movement. Thus, any representation of that movement on a 2-dimensional screen (such as the screen disclosed in Figures 2 and 6) is a 2-dimensional representation of movement, which may occur in three dimensions.

49. The '978 patent discloses a "2-dimensional movement in a display plane" which ***may*** represent a "segment of movement in the display plane." *Id.* 31:59-67. But it does not require that the movement that is reflected be solely 2-dimensional as Samsung's construction appears to require. Other examples from the specification further support this conclusion. For example, the Abstract states that "The computing processor uses the orientation output and the rotation output to generate a transformed output associated with a fixed reference frame associated with the display device. The transformed output represents a segment of the movement pattern." Yet another disclosure states that "the orientation output ***and*** the rotation output" are used to "generate a transformed output associated with a fixed reference frame associated with a display device." *Id.* 8:10-12. And, as discussed above, the transformed output may originate from ***a 3-axis*** accelerometer, ***3-axis*** gyroscope, and ***3-axis*** magnetometer. The Summary of Invention states "According to another example embodiment of the present invention, an electronic device capable of ***generating 3D deviation angles*** and for use in for example computers, motion detection or navigation is provided" and "furthermore, based on the deviation angles being compensated and

accurately outputted in ***3D spatial reference frame*** may be further ***mapped onto*** or translated into another reference frame such as the abovementioned display frame, for example ***a reference in two-dimension (2D)***." *Id.* 5:12-15, 5:41-45 (emphases added).

50. CyWee's construction allows for the transformed output to represent 3-dimensional movement, which includes, but is not limited to, 2-dimensional movement. Absent a clear statement in the '978 patent that the transformed output cannot represent 3-dimensional movement in a 2-dimensional manner, in my opinion there is insufficient justification to limit the scope of the claim as Samsung requests.

F. "generating the orientation output based on the first signal set, the second signal set and the rotation output or based on the first signal set and the second signal set" ('978 patent claim 10)

51. CyWee proposes that this term need not be construed. In the alternative, CyWee proposes that this term be construed as "generating the orientation/deviation angle output based on (1) the first signal set (from an accelerometer), the second signal set (from a magnetometer) and the rotation output (from a rotation sensor or gyroscope) or (2) the first signal set (from an accelerometer) and the second signal set (from a magnetometer)." Samsung alleges that this term is indefinite. In my opinion this term is not indefinite because it informs, with reasonable certainty, a person of ordinary skill in the art, of the scope of the invention. Further, it is my opinion that, while this term need not be construed, it has the meaning proposed by CyWee.

52. The '978 patent provides support for CyWee's construction. First, CyWee's construction states that the ***first signal set*** originates from the ***accelerometer***. This is consistent with claim 10's requirement of "an accelerometer, generating a first signal set." Second, CyWee's construction states that the ***second signal set*** originates from a ***magnetometer***. This is consistent with claim 10's requirement of "a magnetometer, generating a second signal set."

53. Further, the patent states elsewhere that the rotation sensor may include one or more

gyroscopes, consistent with CyWee's construction. '978 patent 5:57-61. Consistent with this disclosure, a person of ordinary skill in the art would understand that the terms "rotation sensor" and "gyroscope" may be used interchangeably and that the function of either is to measure angular velocities.

54. Finally, a person of ordinary skill in the art would understand the claimed "orientation output" to signify the angular position or attitude of the pointing device. Several disclosures in specification clarify this understanding. *E.g.*, '978 patent 7:57-61 ("The orientation sensor generates an orientation output associated with an orientation of the 3D pointing device associated with three coordinate axes of a global reference frame associated with the Earth."), 31:4-9 ("The computing processor 348 may generate the aforementioned orientation output in the form of a rotation matrix, a quaternion, a rotation vector, or in a form including the three orientation angles yaw, pitch and roll.").

55. Because a person of ordinary skill in the art would understand, with reasonable certainty, the scope of this term, it is my opinion that the term is not indefinite. It is also my opinion that, while this term need not be construed, it has the meaning proposed by CyWee.

G. "3D pointing device" ('978 patent claim 10)

56. CyWee proposes that this term need not be construed. In the alternative, CyWee proposed that this term may be construed as "a handheld device that includes at least one or more accelerometers and a magnetometer, and optionally a rotation sensor comprising one or more gyroscopes, and uses them to determine deviation angles or the orientation of a device." Samsung alleges that this term should be construed as "a device that detects the motion of the device in three-dimensions and translates the detected motions to control the movement of a cursor or pointer on a display." In my opinion, this term has the meaning proposed by CyWee when read in light of the intrinsic evidence.

57. The ’978 patent itself provides support for CyWee’s construction. Claim 10 requires a ***magnetometer*** through its requirement of “generating a second signal set associated with Earth’s magnetism.” The specification states that the magnetometer may in fact include multiple magnetometers: “the abovementioned magnetometer may comprise three magnetic sensors such as magneto-impedance (MI) sensors or magneto-resistive (MR) sensors

58. Claim 10 requires an ***accelerometer*** through its requirement of “generating a first signal set comprising axial accelerations associated with movements and rotations of the 3D pointing device . . .” The specification states that the accelerometer may in fact include multiple accelerometers: “the abovementioned ***accelerometer may comprise three accelerometers*** corresponding to each of the said axial accelerations Ax, Ay, Az in a 3D spatial pointer reference frame of the 3D pointing device.” ’978 patent 5:61-64 (emphasis added). Claim 10 also states that a rotation sensor may but need not be included through its requirement of “generating orientation output based on the first signal set, the second signal set and ***the rotation output*** or based on the first signal set and the second signal set.” The specification states that the rotation sensor can include more than one gyroscope: “the abovementioned ***rotation sensor may comprise three gyroscopes*** corresponding to each of the said angular velocities of ω_x, ω_y, ω_z in a 3D spatial pointer reference frame of the 3D pointing device.” *Id.* 5:58-61 (emphasis added).

59. Further, the specification repeatedly discloses a portable ***handheld*** device. More specifically, Figures 1 and 2 disclose prior art pointing devices, and Figures 3 and 5 disclose embodiments of the present invention. All are handheld devices. And the specification repeatedly states that it is directed to portable devices. *Id.* 1:29-31, (“FIG. 1 is a schematic diagram showing a user using a portable electronic device 110, such as a 3D pointing device . . . .”); 13:5-6 (“FIG. 6 is an exploded diagram showing a portable electronic device 600, such as for example a 3D

pointing device . . . . examples of the portable electronic device 600 as an explanatory embodiment of the present invention may include such as smartphone, tablet PC or navigation equipment”).

60. The specification also repeatedly discloses that the pointing device is for determining deviation angles or the orientation of the device as required by CyWee’s construction. For example, the Abstract describes “A three-dimensional (3D) pointing device capable of accurately outputting a deviation . . . .” Figures 7 and 8 provide flow charts of the patented invention. The last step in Figure 7 and the second-to-last step in Figure 8 is “[o]btain resultant deviation . . . .” And the specification repeatedly discloses the determination of deviation angles. *E.g.* 4:15-26 (“According the one aspect of an example embodiment of the present invention . . . such that resulting deviation including resultant angles . . . of the 3D pointing device subject to movements and rotations in dynamic environments may be obtained . . . .); 5:31-35 (“In other words, the present invention is capable of accurately outputting the abovementioned deviation angles . . . to eliminate or reduce accumulated errors and noises . . . .”).

61. In my opinion, Samsung’s proposed construction is overly narrow in its requirement that “detected motions . . . control the movement of a cursor or pointer on a display.” Claim 10 already requires a “transformed output,” which relates to visual output and is being construed separately. Further, the patent discloses an embodiment in which the display is integrated with the pointing device itself. ’978 patent Fig. 6. The specification states that, in such an embodiment the computing processor may map the resulting deviation to a ***movement pattern*** appearing on the display:

> The computing processor 648 of the processing and transmitting module 604 ***may too perform the mapping of resultant deviation*** from or in said spatial reference frame or 3D reference frame to a display reference frame such as a 2D reference frame by translating the resultant angles of the resulting deviation of the electronic device 600 in the spatial reference frame, preferably about each of three orthogonal coordinate axes of the spatial reference frame ***to a movement pattern in a display***

> ***reference frame*** associated with the electronic device 600 itself. ***The display 682 displays the aforementioned movement pattern***.

Id. 13:48-58. But there is no requirement that the movement pattern includes a pointer or cursor. Similarly, the embodiment disclosed in Figure 8 discloses a 3D pointing device that "translate[s] the resultant angles to ***movement pattern*** in the display reference frame." (emphasis added). Further the specification clearly discloses that a cursor may but need not be displayed in other embodiments. *Id.* 21:61-63 ("The display device ***may*** display a cursor ***or some video effect*** on the display screen 910 to highlight the position of the target point 924."), 32:2-3 ("the display device may be controlled to move a ***virtual object*** or a cursor along the movement pattern."). In my opinion, Samsung's construction is overly narrow in light of these disclosures.

H. "global reference frame associated with Earth" ('978 patent claim 10)

62. CyWee contends that this term need not be construed. In the alternative, CyWee contends that this term should be construed as "reference frame with axes defined with respect to the Earth." Samsung proposes that this term be construed as "an Earth-centered coordinate system with an origin and a set of three coordinate axes defined with respect to Earth." In my opinion, this term has the meaning proposed by CyWee.

63. In my opinion, Samsung's proposed construction is overly narrow. "Earth-Centered" coordinate systems or reference frames specifically refer to systems with their origin at the ***center of the Earth***. *See* Noureldin et al., Fundamentals of Inertial Navigation, Satellite-based Positioning and their Integration, Springer-Verlag Berlin, Heidelberg, 2013 ("Noureldin"). Noureldin describes several such Earth-Centered frames, specifically in Chapter 2 Basic Navigational Mathematics, Reference Frames and the Earth's Geometer. For example, Section 2.2.1 describes the Earth-Centered Inertial Frame, which has its origin at the center of the Earth, the z-axis oriented through the North Pole, and the x-axis through the equator and fixed with

respect to an astronomical body, such as the vernal equinox or the center of the sun on a particular date and time. Hence this frame does not rotate with the Earth. Section 2.2.2 of Noureldin describes Earth-Centered fixed frames in which the origin is the center of the Earth, the z-axis is oriented through the North Pole, and the x-axis is through the equator at a specific longitude, such as 0^o (the Prime Meridian in Greenwich, UK).

64. Samsung's Earth-centered construction is overly limiting in the scope of the patent, particularly since many devices and applications are likely to use other conventions, such as the common North-East-Down (NED) or East-North-Up (ENU) reference frames. Noureldin describes these frames in Section 2.2.3. For the ENU frame, the origin coincides with the center of the sensor frame in a plane tangent to the Earth, the y-axis points north in a plane tangent to the Earth, the x-axis points to east, and the z-axis points up (e.g. along the negative of the direction of gravity). *See id.* § 2.2.3. The similar NED frame orients the z-axis down towards the center of the Earth, and thus gives a left-handed frame (left handed frames are less common for orientation estimation). *Id.* Samsung's construction excludes these frames because the origin is not at the center of the Earth.

65. It is worth noting that the '978 patent does not contain the language "Earth-Centered" at any point. Furthermore, for a person of ordinary skill in the art would understand that it is always possible to convert/transform from coordinates in one frame to another (e.g. from Earth-centered to ENU), as discussed in Noureldin et al., Section 2.3. Therefore, there is no reason to limit the construction of the frame to be Earth-Centered.

1/12/2018
Date

Joseph J. LaViola, Jr., Ph.D

EXHIBIT A

TO DECLARATION OF JOSEPH LAVIOLA

JOSEPH J. LAVIOLA JR.
Curriculum Vitae

University of Central Florida
Department of Computer Science
Orlando, FL 32816-2362
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RESEARCH INTERESTS

User interfaces, interactive 2D and 3D graphics, human robot interaction, pattern recognition

EDUCATION

2005: **Ph.D.**, Computer Science, Brown University
Dissertation: "Mathematical Sketching: A New Approach to Creating and Exploring Dynamic Illustrations"
Advisor: Andries van Dam

2001: **Sc.M.**, Applied Mathematics, Brown University

2000: **Sc.M.**, Computer Science, Brown University
Thesis: "Whole-Hand and Speech Input in Virtual Environments"

1996: **B.S.**, Computer Science, Florida Atlantic University

PROFESSIONAL EXPERIENCE

2015-Present: Director of the Modeling and Simulation Graduate Program, University of Central Florida, Orlando, FL

2015-Present: Charles N. Millican Faculty Fellow and Associate Professor of Computer Science, University of Central Florida, Orlando, FL

2014-Present: Director of the Interactive Computing Experiences Research Cluster of Excellence, University of Central Florida, Orlando, FL

2008-Present: Affiliated Research Faculty, Institute for Simulation and Training, University of Central Florida, Orlando, FL

2013-Present: Adjunct Associate Professor of Computer Science, Brown University, Providence, RI

2005-Present: Co-founder and VP of Business Strategy, Fluidity Software, Inc., Somerville, MA

2000-Present: Consultant, JJL Interface Consultants, Inc., Oviedo, FL

Consulting services for user interface design and patent litigation. My consultancies include Nextron Medical Technologies, Physion, Inc., Bellissima Cosmetics, Rosebud LMS, Inc., McKinsey and Co., Microsoft Research, Sixense Entertainment, Inc. (Advisory Board Member), SNR Denton, Williams & Connolly LLP, Activision, InGenius Prep, Meta, Raytheon

2012-2015: CAE Link Professor and Associate Professor with Tenure in EECS, University of Central Florida, Orlando, FL

2006-2013: Adjunct Assistant Professor of Computer Science (Research), Brown University, Providence, RI

2010-2012: SAIC Faculty Fellow and Assistant Professor in EECS, University of Central Florida, Orlando, FL

2007-2010: Assistant Professor, University of Central Florida, Orlando, FL

2006-2009: Research Faculty, Microsoft Center for Research on Pen-Centric Computing, Providence, RI

2005-2006: Postdoctoral Research Associate, Brown University, Providence, RI

Continuing work in mathematical sketching as well as exploring how different orientation tracking algorithms work in augmented reality environments.

1998-2005: Research Assistant**,** Brown University Computer Graphics Lab, Providence, RI

Developed mathematical sketching, an approach to making dynamic illustrations through the combination of handwritten mathematics and free-form drawings and created a mathematical expression recognition system. Studied how different factors such as motion style, sampling rate, prediction time, and noise variance affected various prediction algorithms for human motion tracking in virtual environments. Explored how multimodal interfaces could be used in virtual environments as well as the general topic of improving 3D interfaces in virtual environments. Assisted in the startup and development of the Brown University Technology Center for Advanced Scientific Computing and Visualization.

1999: Teaching Assistant, Brown University, CS-295-5, Interdisciplinary Scientific Visualization

Maintained course web page, prepared class notes, graded homework.

1997: Research Scientist, Fraunhofer Center for Research in Computer Graphics, Providence, RI

Developed demonstration applications for a table-based virtual environment display system utilizing 2D and 3D gesture-based interface techniques.

1996: Software Technician, UCS, Inc., Fort Lauderdale, FL

Performed software test automation and software quality assurance.

1995: Student Intern, IBM, Boca Raton FL

Maintained SQL database query system and performed website development tasks.

HONORS AND AWARDS

2017: UCF Research Incentive Award (RIA)

2017: ACM CHI 2017 Honorable Mention Paper (top 5% of all paper submissions)

2016: Best Paper Award, Ninth IEEE International Conference on the Internet of Things 2016

2016: ACM CHI 2016 Honorable Mention Paper (top 4% of all paper submissions)

2015: Michael A. J. Sweeny Best Student HCI Paper Award – Graphics Interface 2015

2014: ACM CHI 2014 Honorable Mention Paper (top 5% of all paper submissions)

2014: UCF Reach for the Stars Award

2013: UCF Teaching Incentive Program Award (TIP)

2013: UCF Scholarship of Teaching and Learning Award (SOTL)

2013: UCF College of Engineering and Computer Science Deans Research Professorship Award

2013: UCF College of Engineering and Computer Science Excellence in Graduate Teaching Award

2012: Appointed the CAE Link Professor in Electrical Engineering and Computer Science at UCF

2012: UCF Research Incentive Award (RIA)

2012: Named IEEE Senior Member

2011: Best Paper Award, 8th International Conference on Advances in Computer Entertainment Technology

2011: Named ACM Senior Member

2011: Best Poster Award, Eurographics/ACM Symposium on Sketch-Based Interfaces and Modeling

2011: Named to the Eurographics Sketch-Based Interfaces and Modeling steering committee

2010: Appointed the SAIC Faculty Fellow in Electrical Engineering and Computer Science at UCF

2010: ACM CHI 2010 Honorable Mention Paper (top 5% of all paper submissions)

2010: UCF College of Engineering and Computer Science Distinguished Researcher Award

2009: Best Paper Award, Eurographics/ACM Symposium on Sketch-Based Interfaces and Modeling

2009: National Science Foundation CAREER Award

2008: Best Paper Award, 9th International Symposium on Smart Graphics

2007: UCF Presidential Major Equipment Award

2006: Best Paper Award, Eurographics Workshop on Sketch-Based Interfaces and Modeling

2004: Best Paper Presentation (Applied Estimation Session), 2004 American Control Conference

2000-2002, 2004: The van Dam Fellowship

1998: IBM Cooperative Fellowship

1996: FAU's Aaron Finerman Award

1996: FAU's Faculty Award for Outstanding Undergraduate Achievement

1995: Microsoft Senior Achievement Award

Also elected to Sigma Xi (1998), Phi Kappa Phi (1995), and Phi Eta Sigma (1993)

RESEARCH CONTACTS AND GRANTS

Total Funding: $4,672,885
Total as PI: $3,880,885
Total as Co-PI: $792,000
My Share at UCF: $3,876,798

Active Grants and Contracts

"NRI: Collaborative Research: Sketching Geometry and Physics Informed Inference for Mobile Robot Manipulation in Cluttered Scenes", NSF Award IIS-1638060, $286,434, Sole PI (100% credit), Sept. 2016 – August 2019.

"RF: Improving Augmented Reality Technologies for Training and Education", Lockheed Martin Corporation, $200,000, PI (80% credit equals $160,000), Aug. 2016 – Aug. 2018.

"FHTCC: Improving Augmented Reality Technologies for Training and Education", UCF/I-4 Match, $66,666 PI (80% credit equals $52,800), Aug. 2016 – Aug. 2018.

"Interactive Visualization in Support of Decision Making under Uncertainty", Office of Naval Research Award ONRBAA15001, $660,000, Co-PI, (54.5% credit equals $360,000), Sept. 2015 – Oct. 2018.

"Augmented Reality-Based Intelligent Tutoring in the Wild", US Army RDECOM –STC Award W911QX13C0052, $489,376, Sole PI (100% credit), Dec. 2014 – April 2018.

Past Grants and Contracts

"Exploring the Benefits of Spatial IDEs", Coda Enterprises, LLC, $47,500, Sole PI (100% credit), Jan. 2016 – May 2017.

"Physics Based Multi-Touch Movement Interface Creation for 3D Modeling and Simulation, Phase II", JHT Incorporated Award JHT13S0002 (Navy SBIR Phase II, Topic N121-061), $187,500, Sole PI (100% credit), Oct. 2013 – Mar. 2016.

"Physics Based Multi-Touch Movement Interface Creation for 3D Modeling and Simulation, Phase II", UCF/I-4 Match, $122,270, Sole PI (100% credit), Aug. 2013 – Mar. 2016.

"CAREER: Mathematical Sketching: Pen-based Tools for Conceptual Understanding in Mathematics and Physics", NSF CAREER Award IIS-0845921, $459,776, Sole PI (100% credit), May 2009 – April 2016.

"REU Supplement to CAREER: Mathematical Sketching: Pen-based Tools for Conceptual Understanding in Mathematics and Physics", NSF CAREER Award IIS-0845921, $80,000, Sole PI (100% credit), May 2009 – April 2016.

"SHF: Large: A Working Set Approach to Integrated Development Environments", NSF Award CCF-1012056, Sole PI (100% credit) on Subcontract from Brown University, $179,823 of $1,123,918, Aug. 2010 – July 2015.

"Major: Enhancing Creativity and Authoring in STEM Education-Based Virtual Worlds through Concept-Oriented Design", NSF Award IIS-0856045, $755,845, PI $753,835, PI (70% credit equals $527,684), July 2009 – June 2014.

"REU Supplement to Major: Enhancing Creativity and Authoring in STEM Education-Based Virtual Worlds through Concept-Oriented Design", NSF Award IIS-0856045, $40,000, Sole PI (100% credit), July 2010 – June 2014.

"Healthcare Informatics, Implementation, Long Term Care and Aging", James A. Haley Veterans' Hospital, $26,661, Sole PI (100% credit), April 2013 – Mar. 2014.

"Feasibility for the Development of a Physics, Navigation, and Meta Gestures API for Training, Simulations, and Entertainment", JHT Incorporated Award JHT12S0003 (Navy SBIR Phase I, Topic N121-061), $42,100, Sole PI (100% credit), June 2012 – Dec. 2013.

"Feasibility for the Development of a Physics, Navigation, and Meta Gestures API for Training, Simulations, and Entertainment", UCF/I-4 Match, $14,033, Sole PI (100% credit), July 2012 – Dec. 2013.

"Extending Smart Home Technology for Cognitively Impaired Veterans to Delay Institutionalization (Part II)", James A. Haley Veterans' Hospital, $33,000, Sole PI (100% credit), April 2013 – Sept. 2013.

"Naturalistic Operator Interface for Immersive Environments", Design Interactive, Inc. Award EGO6389UCF (DoD OSD SBIR Phase I), $49,700, PI (50% credit equals $24,850), March 2013 – Aug. 2013.

"Naturalistic Operator Interface for Immersive Environments", UCF/I-4 Match, $16,666, PI (50% credit equals $8,333), March 2013 – Aug. 2013.

"Robot Platforms for Research and Education in Human Robot Interaction", UCF Major Research Equipment Award, $54,200, PI (50% credit equals $27,100), Feb. 2013 – June 2013.

"Dynamic 3D Stereo Visualization of Physics Concepts through a Hybrid Stylus Interface", Infinite Z, $10,000, PI (100% credit), Dec. 2012 – Aug. 2013.

"VR and Gaming Project Exploration", James A. Haley Veterans' Hospital Award VA673C10812, $40,000, PI (100% credit), Sept. 2011 – Jan. 2013.

"Personalized Self-Efficacy Virtual Environment Recovery Experience (PERSEVERE)", Intelligent Automation, Inc. Award 9762 (NIH SBIR Phase I, Topic 141), $15,889, PI (100% credit), Aug. 2012 – Jan. 2013.

"Realistic Full Body Interfaces for Locomotion and Communication in 3D Virtual Environments", US Army RDECOM Award W91CRB-10-C-0212, $175,000, PI (100% credit), Sept. 2010 – Dec. 2012.

"Prototyping Tools for Unobtrusive Mood Assessment", RDECOM-STC Award W91CRB-09-C-0504, $150,000, PI (100% credit), May 2009 – Sept. 2011.

"Deep Green Program Support", Science Applications International Corporation Award 4400157271, $60,247, Sole PI (100% credit), June 2008 – June 2009.

"Deep Green Program Support", UCF/I-4 Match, $33,614, Sole PI (100% credit), July 2008 – June 2009.

"Interaction and the Analyst Workstation of the Future", US Air Force Research Lab Award FA87500820202, $70,000, Sole PI (100% credit), June 2008 – June 2009.

"Sketching Mathematical Algorithms", US Air Force Research Lab A-SpaceX Award FA8750-08-C-0131, Sole PI (100% credit) on Subcontract from Brown University, $53,078 of $250,000, Feb. 2008 – Feb. 2009.

"Pre-Visualization of Content Creation and User Experience for Free-Choice Learning Venues", UCF Presidential Major Equipment Award, $47,574, PI (50% credit equals $23,787), Dec. 2007 – Nov. 2008.

"Sketching Mathematical Algorithms", Disruptive Technology Office A-SpaceX Award N61339-06-C-0186, Sole PI (100% credit) on Subcontract from Brown University, $75,943 of $350,000, Sept. 2006 – Dec. 2007.

"Adaptive Real-Time Learning for Mathematical Expression Recognition in Mathematical Sketching", NSF STTR Phase I Award OII-0611012, $132,000, Co-PI (23% credit), PI: Donald P. Carney, July 2006 – June 2007.

PUBLICATIONS

Total Citations (according to Google Scholar): 7047
h-index: 35

Books

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Bowman, D., Kruijff, E., LaViola, J., and Poupyrev, I. *3D User Interfaces: Theory and Practice*, Addison Wesley, July 2004. (cited 1656 times, source: Google Scholar)

Book Chapters

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Williamson, B., Wingrave, C., and LaViola, J. "Full Body Locomotion with Video Game Motion Controllers". *Human Walking in Virtual Environments*, F. Steinicke, Y. Visell, J. Campos, and A. Lecuyer (eds.), Springer, 351-376, May 2013.

LaViola, J. "Mathematical Sketching: An Approach to Making Dynamic Illustrations". *Sketch-based Interfaces and Modeling*, J. Jorge and F. Samavati (eds.), Springer Verlag London Limited, 81-118, December 2010.

LaViola, J. "Input Devices", *Wiley Encyclopedia of Computer Science and Engineering*, B. Wah (ed.), Wiley, Vol.3, 1575-1584, January 2009.

LaViola, J., Prabhat, Forsberg, A., Laidlaw, D., and van Dam, A. "Virtual Reality-Based Interactive Scientific Visualization Environments". *Trends in Interactive Visualization: State-of-the-Art Survey*, E. Zudilova-Seinstra, T. Adriaansen, and R. van Liere (eds.), Springer Verlag London Limited, 225-250, January 2009.

Edited Books

LaViola, J., Pan, Z., Coquillart, S., and Schmalstieg, D. (eds.) *IEEE Virtual Reality 2013*, IEEE Press, March 2013.

Billinghurst, M., LaViola, J., and Lecuyer, A. (eds.) *IEEE Symposium on 3D User Interfaces 2012*, IEEE Press, March 2012.

LaViola, J., Hachet, M., and Billinghurst, M. (eds.) *IEEE Symposium on 3D User Interfaces 2011*, IEEE Press, March 2011.

Hachet, M., Kiyokawa, K., and LaViola, J. (eds.) *IEEE Symposium on 3D User Interfaces 2010*, IEEE Press, March 2010.

Grimm C. and LaViola J. (eds.). *ACM SIGGRAPH/Eurographics Symposium Proceedings: Sketch-Based Interfaces and Modeling 2009*, ACM Press, August 2009.

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Vargas, A., Kapalo, K., Koh, S., and LaViola, J. "Exploring the Virtuality Continuum for Complex Rule-Set Education in the Context of Soccer Rule Comprehension", *Multimodal Technologies and Interaction*, 1(4): Article 30 (15 pages), November 2017.

Kulshreshth, A., Pfeil, K., and LaViola, J. "Enhancing the Gaming Experience Using 3D Spatial User Interface Technologies", *IEEE Computer Graphics and Applications*, 38(3):16-23, May-June 2017.

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Taranta, E., Vargas, A., and LaViola, J. "Streamlined and Accurate Gesture Recognition with Penny Pincher", *Computers and Graphics*, Volume 55, 130-142, April 2016.

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Buchanan, S. and LaViola J., "CSTutor: A Sketch-Based Tool for Visualizing Data Structures", *ACM Transactions of Computing Education*, 14(1):Article 3 (28 pages), March 2014.

Reiss, S., Bott, J., and LaViola, J., "Plugging In and Into Code Bubbles: The Code Bubbles Architecture", *Journal of Software: Practice and Experience*, 44(3):261-276, March 2014.

LaViola, J., "3D Gestural Interaction: The State of the Field," *ISRN Artificial Intelligence*, Vol. 2013, Article ID 514641, 18 pages, 2013.

Gupta, P., Lobo, N., and LaViola, J. "Markerless Tracking and Gesture Recognition using Polar Correlation of Camera Optical Flow", *Machine Vision and Applications*, 24(3):651-666, April 2013.

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Cheema, S., Hoffman, M., and LaViola, J. "3D Gesture Classification With Linear Acceleration and Angular Velocity Sensing Devices for Video Games", *Entertainment Computing*, 4(1):11-24, February 2013.

Tomlinson, B., Patterson, D., Pan, Y., Blevis, B., Nardi, B. Silberman, S., Norton, J., and LaViola, J. "What If Sustainability Doesn't Work Out?", *Interactions*, 19(6):50-55, November/December 2012.

Varcholik, P., LaViola, J., and Hughes, C. "Establishing a Baseline for Text Entry for a Multi-Touch Virtual Keyboard", *International Journal of Human-Computer Studies*, 70(10):657-672, October 2012.

Cashion, J., Wingrave, C., and LaViola, J. "Dense and Dynamic 3D Selection for Game-based Virtual Environments", *IEEE Transactions on Visualization and Computer Graphics (Proceedings of Virtual Reality 2012)*, 18(4):634-642, April 2012.

Miller, A., White. B., Charbonneau, E., Kanzler, Z., and LaViola, J. "Interactive 3D Model Acquisition and Tracking of Building Block Structures", *IEEE Transactions on Visualization and Computer Graphics (Proceedings of Virtual Reality 2012)*, 18(4):651-659, April 2012.

Xiong, Y. and LaViola, J. "A ShortStraw-Based Algorithm for Corner Finding in Sketch-Based Interfaces", *Computers and Graphics*, 34(5):513-527, October 2010.

Wingrave, C. and LaViola, J. "Reflection on the Design and Implementation of Virtual Environments", *PRESENCE: Teleoperators and Virtual Environments*, 19(2):179-195, April 2010.

Wingrave, C., Williamson, B. , Varcholik, P., Rose, J., Miller, A., Charbonneau, E., Bott, J. and LaViola, J. "Wii Remote and Beyond: Using Spatially Convenient Devices for 3DUIs", *IEEE Computer Graphics and Applications*, 30(2):71-85, March/April 2010. (cited 121 times, source: Google Scholar)

Wingrave, C., LaViola, J. and Bowman, D. "A Natural, Tiered and Executable UIDL for 3D User Interfaces Based on Concept-Oriented Design", *ACM Transactions on Computer-Human Interaction (TOCHI)*, 16(4):Article 21 (36 pages), November 2009.

Zeleznik, R., Miller, T., van Dam, A., Li, C., Tenneson, D., Maloney, C., and LaViola, J. "Applications and Issues in Pen-Centric Computing", *IEEE Multimedia*, 15(4):14-21, October-December 2008.

LaViola, J. "Bringing VR and Spatial 3D Interaction to the Masses through Video Games", *IEEE Computer Graphics and Applications*, 28(5):10-15, September/October 2008.

LaViola, J., and Zeleznik, R. "A Practical Approach to Writer-Dependent Symbol Recognition Using a Writer-Independent Recognizer", *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 29(11):1917-1926, November 2007.

LaViola, J. "An Initial Evaluation of MathPad^2: A Tool for Creating Dynamic Mathematical Illustrations", *Computers and Graphics*, 31(4):540-553, August 2007.

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LaViola, J. “Introduction to 3D Gestural User Interfaces”, *ACM SIGGRAPH 2014 Courses*, Presented at ACM SIGGRAPH 2014, Vancouver, Canada, Article 25: 42 pages, August 2014.

LaViola, J. and Keefe, D. “3D Spatial Interaction: Applications for Art, Design, and Science”, Course #1, Presented at ACM SIGGRAPH 2011, Vancouver, Canada, August 2011.

LaViola, J. and Marks, R. “An Introduction to 3D Spatial Interaction with Video Game Motion Controllers”, Course #2, Presented at ACM SIGGRAPH 2010, Los Angeles, California, July 2010.

Otaduy, M., Igarashi, T., and LaViola, J. “Interaction: Interfaces, Algorithms, and Applications”, Course #6, Presented at ACM SIGGRAPH 2009, New Orleans, Louisiana, August 2009.

LaViola, J., Kruijff, E., Bowman, D., Poupyrev, I., and Stuerzlinger, W. “3D User Interfaces: Design, Implementation, Usability”, Course #16, Presented at ACM CHI 2009, Boston, Massachusetts, April 2009.

Kruijff, E., Bowman, D., LaViola, J., and Poupyrev, I. “3D User Interfaces: From Lab to Living Room”, Course #17, Presented at ACM CHI 2008, Florence, Italy, April 2008.

LaViola, J., Igarashi, I., Alvarado, C., and Lipson, H. “Sketch-Based Interfaces: Techniques and Applications”, Course #3, Presented at ACM SIGGRAPH 2007, San Diego, California, August 2007.

LaViola, J., Davis, R., and Igarashi, I. “An Introduction to Sketch-Based Interfaces”, Course #18, Presented at ACM SIGGRAPH 2006, Boston, Massachusetts, July 2006.

Bowman, D., LaViola, J., Mine, M., and Poupyrev, I. “Advanced Topics in 3D User Interface Design”, Course #44, Presented at ACM SIGGRAPH 2001, Los Angeles, California, August 2001.

Bowman, D., Kruijff, E., LaViola, J., Mine, M., and Poupyrev, I. “3D User Interface Design: Fundamental Techniques, Theory, and Practice”, Course #36, Presented at ACM SIGGRAPH 2000, New Orleans, Louisiana, July 2000.

Bowman, D., Kruijff, E., LaViola, J., and Poupyrev, I. “The Art and Science of 3D Interaction”, Full-day tutorial presented at IEEE Virtual Reality 2000, New Brunswick, New Jersey, March 2000.

Bowman, D. Kruijff, E., LaViola, J., Mine, M., and Poupyrev, I. “The Art and Science of 3D Interaction”, Full-day tutorial presented at the ACM Symposium on Virtual Reality Software and Technology, London, England, December 1999.

Bowman, D., Kruijff, E., LaViola, J., and Poupyrev, I. “The Art and Science of 3D Interaction”, Full-day tutorial presented at IEEE Virtual Reality '99, Houston, Texas, March 1999.

Patents

Gulwani, S., Cheema, S., and LaViola J. “Sketch Beautification of and Completion of Partial Structured Drawings”, US Patent 9,098,191, August 2015.

Gupta, P., Lobo, N., and LaViola, J. “Object Tracking with Opposing Image Capture Devices”, US Patent 8,983,127, March, 2015.

Other Publications

Desingh, K., Maghoumi, M., Jenkins, O., LaViola, J., and Reveret, L. “Object Manipulation in Cluttered Scenes Informed by Physics and Sketching”, *RSS 2016 Workshop: Geometry and Beyond - Representations, Physics, and Scene Understanding for Robotics*, June 2016.

Wingrave, C., Norton, J., and LaViola, J. "Using Minecraft for Instruction and Creative Play", *CHI 2012 Workshop on Educational Interfaces, Software, and Technology*, May 2012.

Norton, J., Stringfellow, A., and LaViola, J. "Domestic Plant Guilds: A Novel Application for Sustainable HCI", *CHI 2012 Workshop on Simple, Sustainable Living*, May 2012.

Buchanan, S., Ochs, B., and LaViola, J. "CS Tutor: A Pen-Based Tool for Visualizing Data Structures", *Eighth Eurographics/ACM Symposium on Sketch-Based Interfaces and Modeling 2011*, August 2011. (Best Poster Award)

Wingrave, C., Hoffman, M., Sottilare, R. and LaViola, J. "Unobtrusive Mood Assessment for Training Applications", *CHI 2011 Workshop on Brain and Body Interfaces: Designing for Meaningful Interaction*, May 2011.

Bott, J. and LaViola, J. "The WOZ Math Recognizer: A Mathematics Handwriting Recognition Wizard of Oz Tool", Technical Report CS-TR-11-03, University of Central Florida, Department of Electrical Engineering and Computer Science, Orlando, FL, May 2011.

LaViola, J. "The Killer App for Sketch-Based Interfaces is …", *CHI 2010 Workshop on Designing Sketch Recognition Interfaces*, 54-57, April 2010.

Reiter, J., Kirby, R. M., and LaViola, J. "Immersive Hierarchical Visualization and Steering for Spectral/hp Element Methods", Technical Report CS-01-03, Brown University, Department of Computer Science, Providence RI, May 2001.

LaViola, J. "A Survey of Hand Posture and Gesture Recognition Techniques and Technology", Technical Report CS-99-11, Brown University, Department of Computer Science, Providence RI, June 1999. (cited 192 times, source: Google Scholar)

Pickering, J., Bhuphaibool, D., LaViola, J., and Pollard, N. "The Coach's Playbook", Technical Report CS-99-08, Brown University, Department of Computer Science, Providence RI, May 1999.

Forsberg, A., LaViola, J., and Zeleznik, R. "Incorporating Speech Input into Gesture-Based Graphics Applications at The Brown University Graphics Lab", *CHI'99 Workshop on Designing the User Interface for Pen and Speech Multimedia Applications*, May 1999.

LaViola, J., Forsberg, A., and Zeleznik, R. "Jot: A Framework for Interface Research", IBM's interVisions Online Magazine, Issue #11, February 1998.

LaViola, J. "Analysis of Mouse Movement Time Based on Varying Control to Display Ratios Using Fitts' Law", Technical Report CS-97-17, Brown University, Department of Computer Science, Providence RI, October 1997.

LaViola, J. "Experiment in VM Reduction, Conversion of Site Operating Procedures to the World Wide Web", IBM Technical Report, TR54.922, December 29, 1995.

STUDENT ADVISING

Post-Doc:

Chadwick Wingrave (2008 – 2012)

PhD

Ravikiran Kattoju, started Fall 2016

Kate Kapalo, started Fall 2016

Amirreza Samiei, started Summer 2016

Kyle Martin, started Summer 2016

Kevin Pfeil, started Fall 2016

Mehran Maghoumi, started Summer 2015

Andres Vargas, started Fall 2014

Eugene Taranta, started Fall 2013

Seng Lee Koh, started Summer 2013

Corey Pittman, started Fall 2012

Sarah Buchanan, Ph.D. 2017. Dissertation Title: Exploring the Multi-touch Interaction Design Space for 3D Virtual Objects to Support Procedural Training Tasks

Jared Bott, Ph.D. 2016. Dissertation Title: The WOZ Recognizer: A Tool For Understanding User Perceptions of Sketch-based Interfaces

Arun Kulshreshth, Ph.D. 2015. Dissertation Title: Exploring 3D User Interface Technologies for Improving the Gaming Experience

Salman Cheema, Ph.D. 2014. Dissertation Title: Pen-Based Methods for Recognition and Animation of Handwritten Physics Solutions

Jeffrey Cashion, Ph.D. 2014. Dissertation Title: Intelligent Selection Techniques for Virtual Environments

Emiko Charbonneau, Ph.D. 2013. Dissertation Title: Bridging the Gap Between Fun and Fitness: Instructional Techniques and Real-World Applications for Full Body Dance Games

Paul Varcholik, Ph.D. 2011. Dissertation Title: Multi-Touch for General-Purpose Computing: An Examination of Text Entry

Masters:

Chuck Greenwood, started Summer 2015

Pooya Khaloo, M.S., 2017, Thesis Title: Code Park: A New 3D Code Visualization Tool and IDE

Andres Vargas, M.S., 2014. Thesis Title: SKETCHART: A Pen-Based Tool for Chart Generation and Interaction

Kevin Pfeil, M.S., 2013. Thesis Title: An Exploration of Unmanned Aerial Vehicle Direct Manipulation Through 3D Spatial Interaction

Travis Cossairt, M.S. 2012. Thesis Title: SetPad: A Sketch-Based Tool for Exploring Discrete Math Set Problems

Tad Litwiller, M.S. 2010. Thesis Title: Evaluating the Benefits of 3D Stereo in Modern Video Games

Prince Gupta, M.S. 2010. Thesis Title: Markerless Tracking Using Polar Correlation of Camera Optical Flow

Brian Williamson, M.S. 2009. Thesis Title: RealNav: Exploring Natural User Interfaces for Locomotion in Video Games

Jared Bott, M.S. 2009. Thesis title: VectorPad: A Tool for Visualizing Vector Operations

Undergraduate:

Anamary Leal, B.S. 2009. Honors Thesis title: Exploring the Effectiveness of 3D File Browsing Techniques for File Searching Tasks

Thesis and Dissertation Committees:

Paul Szerlip, Ph.D., Computer Science, 2015

Amy Hoover, Ph.D., Computer Science, 2014

Yiyan Xiong, Ph.D., Computer Science, 2014

Bennie Lewis, Ph.D., Computer Science, 2014

Subhabrata Bhattacharya, Ph.D., Computer Science, 2013

Joseph Keebler, Ph.D. Psychology, 2011

Kennard Laviers, Ph.D. Computer Science, 2011

Juraj Obert, Ph.D. Computer Science, 2010

Dustin Chertoff, Ph.D., Modeling and Simulation, 2009

Jingen Liu, Ph.D., Computer Science, 2009

TEACHING

* indicates courses I developed and have revised through the years

Course Number	Course Title	Credits	Class	Semester	# of Students	Students Eval Score (out of 5)
COP 3503H	Honors Computer Science II	3	Ugrad	Fall 2017	17	3.17
CAP 6121*	3D User Interfaces for Games and Virtual Reality	3	Grad	Spring 2017	15	4.38
CAP 6105*	Pen-Based User Interfaces	3	Grad	Fall 2016	7	4.67
CAP 6121*	3D User Interfaces for Games and Virtual Reality	3	Grad	Spring 2016	13	4.38
CAP 6105*	Pen-Based User Interfaces	3	Grad	Fall 2015	13	4.0
CAP 6121*	3D User Interfaces for Games and Virtual Reality	3	Grad	Spring 2015	15	4.12
COP 3503H	Honors Computer Science II	3	Ugrad	Fall 2014	12	4.0
CAP 6121*	3D User Interfaces for Games and Virtual Reality	3	Grad	Spring 2014	6	5.0
CAP 6105*	Pen-Based User Interfaces	3	Grad	Fall 2013	7	4.5
CAP 6121*	3D User Interfaces for Games and Virtual Reality	3	Grad	Spring 2013	12	4.0
COP 3503H	Honors Computer Science II	3	Ugrad	Fall 2012	17	3.75
CAP 6105*	Pen-Based User Interfaces	3	Grad	Fall 2012	9	4.67
CAP 6121*	3D User Interfaces for Games and Virtual Reality	3	Grad	Spring 2012	19	3.75
COP 3223	Intro to Programming with C	3	Ugrad	Fall 2011	168	3.18
CAP 6105*	Pen-Based User Interfaces	3	Grad	Fall 2011	10	5.0
CAP 6121*	3D User Interfaces for Games and Virtual Reality	3	Grad	Spring 2011	15	4.33
COP 3223	Introduction to C Programming	3	Ugrad	Fall 2010	226	3.43
CAP6105*	Pen-Based User Interfaces	3	Grad	Fall 2010	10	5.0

CAP 6121*	3D User Interfaces for Games and Virtual Reality	3	Grad	Spring 2010	13	4.5
CAP 6105*	Pen-Based User Interfaces	3	Grad	Fall 2009	14	3.85
COP 3223	Introduction to C Programming	3	Ugrad	Fall 2009	229	2.65
CAP 6938*	3D User Interfaces for Games and Virtual Reality	3	Grad	Spring 2009	14	4.0
CAP 6938*	Topics in Pen-Based User Interfaces	3	Grad	Fall 2008	13	4.0
CAP 6938*	3D User Interfaces for Games and Virtual Reality	3	Grad	Spring 2008	14	4.5
CAP 5937/6938*	Topics in Pen-Based User Interfaces	3	Grad	Fall 2007	19	4.17
COP 3502H	Honors Computer Science I	3	Ugrad	Spring 2007	19	2.89

Other courses taught:

ISC 2215: Applications of Calculus I, UCF EXCEL Program, Co-Instructor (Spring 2012)

ISC 2216: Applications of Calculus II, UCF EXCEL Program, Co-Instructor (Spring 2012)

ISC 2215: Applications of Calculus I, UCF EXCEL Program, Co-Instructor (Fall 2011)

ISC 2215: Applications of Calculus I, UCF EXCEL Program, Co-Instructor (Spring 2011)

ISC 2216: Applications of Calculus II, UCF EXCEL Program, Co-Instructor (Spring 2011)

ISC 2215: Applications of Calculus I, UCF EXCEL Program, Co-Instructor (Fall 2010)

ISC 2215: Applications of Calculus I, UCF EXCEL Program, Co-Instructor (Spring 2010)

ISC 2216: Applications of Calculus II, UCF EXCEL Program, Co-Instructor (Spring 2010)

ISC 2215: Applications of Calculus I, UCF EXCEL Program, Co-Instructor (Fall 2009)

CS 193-33: Independent Study with Michael Katzourin, Department of Computer Science, Brown University (Fall 2006)

INVITED TALKS

“3D Spatial User Interfaces: Past, Present, and Future from the Virtual to the Real”

- Brown University, Providence, RI (May 2015)

"Intelligent Tutoring Interfaces with Mathematical Sketching"

- Duke University, Durham, NC (December 2014)
- Arizona State University, Phoenix, AZ (November 2013)

"QuickDraw: Improving Drawing for Geometric Diagrams"

- Microsoft Research Faculty Summit 2012, Redmond, WA (July 2012)

"3D Spatial Interaction with Commodity Hardware"

- GameTech 2012 Users' Conference, Orlando, FL (March 2012)

"Towards Intelligent Tutoring with Mathematical Sketching"

- INRIA Bordeaux - Sud-Ouest , Talence Cedex, France (July 2011)
- Microsoft Research, Redmond, WA (May 2011)

"Spatial 3D Interaction and Video Games"

- Washington University in St. Louis, St. Louis, MO (December 2008)
- Electronic Arts, Maitland, FL (August 2008)

"Research at the Interactive Systems and User Experience Lab"

- The Burnett Honors College, Orlando, FL (July 2008)

"Mathematics, Physics, and Chemistry: Tablet PC Research and Education"

- Florida Virtual School 14th Annual Staff Conference, Orlando, FL (September 2010)
- Modeling, Simulation, and Training techCAMP, Orlando, FL (January 2008)
- Modeling, Simulation, and Training techCAMP, Orlando, FL (November 2007)

"Mathematics, Physics, and Chemistry: Tablet PC Research and Education at Brown University"

- Pace University, NY, NY (April 2006)

"Mathematical Sketching: A New Approach for Creating and Exploring Dynamic Illustrations"

- Workshop on Computer Graphics: Current Trends in Research and Industry, Lahore University of Management Science, Pakistan (July 2007)
- SUNY Stony Brook, Stony Brook, NY (March 2006)
- Lehigh University, Bethlehem, PA (March 2006)

- University of Central Florida, Orlando, FL (March 2006)
- Aptima, Woburn, MA (September 2005)
- Wolfram Research, Champaign, IL (May 2005)
- Microsoft Research, Redmond, WA (February 2005)
- IBM Thomas J. Watson Research Center, Hawthorne, NY (December 2004)

SERVICE TO THE PROFESSION

Associate Editor: IEEE Computer Graphics & Applications (2013-present)
ACM Transactions on Interactive Intelligent Systems (2013-present)
International Journal of Human-Computer Studies (2010-present)

NSF Panelist: Computer & Information Science &Engineering Directorate (April 2016)
Computer & Information Science &Engineering Directorate (April 2015)
Computer & Information Science & Engineering Directorate (May 2014)
Computer & Information Science & Engineering Directorate (September 2013)
Computer & Information Science & Engineering Directorate (April 2012)
Computer & Information Science & Engineering Directorate (April 2010)
Computer & Information Science & Engineering Directorate (January 2009)
Computer & Information Science & Engineering Directorate (September 2009)

General Chair: Eurographics Symposium on Sketch-Based Interfaces and Modeling 2010

Program Chair: IEEE Virtual Reality 2013
IEEE Symposium on 3D User Interfaces 2012
IEEE Symposium on 3D User Interfaces 2011
IEEE Symposium on 3D User Interfaces 2010
Eurographics Symposium on Sketch-Based Interfaces and Modeling 2009

Associate Program Chair: ACM Intelligent User Interfaces 2012
Foundations of Digital Games 2012

Steering Committees: Eurographics Symposium on Sketch-Based Interfaces and Modeling (2011-2013)

Panels Chair: IEEE Virtual Reality 2006
Publications Chair: IEEE Virtual Reality 2007-2009
Program Committees: ACM Symposium on Spatial User Interaction (2013,2014)
ACM Virtual Reality Software and Technology (2009-2010)
ACM Intelligent User Interfaces (2009, 2018)
Eurographics Short Papers Program (2008)
IEEE Symposium on 3D User Interfaces (2007-2009, 2014, 2017)
IEEE Virtual Reality (2007-2011, 2014)
Eurographics Symposium on Sketch-Based Interfaces and Modeling (2007-2008, 2011, 2012, 2013, 2014, 2017)
6th IEEE International Symposium on Mixed and Augmented Reality (2007)
2nd International Symposium on Visual Computing (2006)

Journal Reviewer: *Human Computer Interaction* (2015)
Computer Vision and Image Understanding (2014)
Presence: Teleoperators and Virtual Environments (2014)
IEEE Transactions on Neural Systems and Rehabilitation Engineering (2012)
ACM Transactions on Multimedia Computing Communications and Applications (2011)
ACM Transactions on Interactive Intelligent Systems (2010-2011)
Journal of Visual Languages and Computing (2009)
ACM Transactions on Computer-Human Interaction (2009, 2014)
IEEE Transactions on Aerospace and Electronic Systems (2009)
International Journal of Human Computer Studies (2008-2011)
Pattern Recognition (2007)
Computers and Graphics (2001, 2006- 2008,2010,2011, 2013)
IEEE Transactions on Pattern Analysis and Machine Intelligence (2007)
IEEE Computer Graphics and Applications (2002-2003, 2005-2006, 2008, 2009)
Computer Animation & Virtual Worlds (2006)
IEEE Transactions on Visualization and Computer Graphics (2005, 2006, 2010,2011)
IEEE Transactions on Robotics (2005)
Virtual Reality (2005, 2010, 2012)
Pattern Recognition Letters (2005)

External Conference Reviewer: ACM/IEEE Human Robot Interaction (2016)
WIPTTE (2015)
ACM Designing Interactive Systems (2014)
ACM Annual Symposium on Computer-Human Interaction in Play (2014)
ACM International Conference on Multimodal Interaction (2013, 2014)
ACM Interactive Tabletops and Surfaces (2010)
ACM SIGGRAPH ASIA (2009,2010)
ACM SIGGRAPH Sketches and Poster's Juror (2007)
Graphics Interface (2005, 2007, 2009, 2010, 2012)
Eurographics Workshop on Virtual Environments (2002, 2004, 2007)
ACM UIST (2003, 2005, 2006, 2008, 2010 - 2017)
ACM CHI (2005-2006, 2010-2018)
ACM Virtual Reality Software and Technology (2005, 2017)
ACM Intelligent User Interfaces (2013, 2018)
IEEE International Symposium on Wearable Computers (2010)
IEEE Virtual Reality (2005, 2012, 2017)
IEEE Visualization (2004)
ACM SIGGRAPH (2004, 2008, 2010, 2011, 2013, 2014, 2017)
12th IEEE Mediterranean Conference on Control and Automation (2004)
IEEE and ACM International Symposium on Mixed and Augmented Reality (2003, 2008, 2009, 2010, 2011, 2012, 2013, 2014)
ACM Symposium on Interactive 3D Graphics (2003)
ACM SIGGRAPH courses (1999)

SERVICE TO UCF

Member, SOTL Review Committee, UCF, 2017
Member, Faculty Search Committee, Modeling and Simulation Graduate Program, 2016
Director, Modeling and Simulation Graduate Program, UCF, 2015-2017
Member, SOTL Review Committee, UCF, 2014
Member, TIP Criteria Committee, CECS, 2014

Member, Faculty Search Committee, EECS, 2013-2016
Member, EECS, Computer Science Division Executive Committee, 2013-2017
Member, EECS, Computer Science Division Website Committee, 2013
Member, Search Committee, Center for Research in Computer Vision, 2012
Member, Lecturer Promotion Committee, EECS, 2012
Member, Graduate Program Advisory Committee for the M&S Graduate Program, 2011-2012
Member, Industrial Advisory Committee, EECS, 2007-2009.
Member, Space Committee, EECS, 2008-2009.
Member, Faculty Search Committee, EECS 2009-2010.
Faculty, UCF EXCEL Program, 2009-2012

REFRENCES

Andries van Dam
Thomas J. Watson, Jr., University Professor of Technology and Education
and Professor of Computer Science
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University of Central Florida
4000 Central Florida Blvd., MH 243
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